APPENDIX H

NOISE AND VIBRATION

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

APPENDIX H
NOISE AND VIBRATION

Appendix H provides additional information on the noise and vibration methodology used in preparing the Supplemental EA and contains the noise and vibration contour maps.

H.1 NOISE EMISSION LEVELS OF TRAIN NOISE SOURCES

The sound propagation modeling occurred in Cadna-A, a three-dimensional acoustical analysis software package designed for evaluating environmental noise from stationary and mobile sources. Cadna-A uses as the basis for its models the International Organization for Standardization (ISO) standard 9613-2, "Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation" (ISO 1996). This standard provides a widely accepted engineering method for the calculation of outdoor environmental noise levels.

The Federal Transit Administration's (FTA's) *Transit Noise and Vibration Impact Assessment* (FTA 2006) provides a method for computing sound levels from fixed-guideway (train) sources. These calculation methods were mathematically manipulated to derive input data that is compatible with the Cadna-A software package. These manipulations yielded a sound power level (symbol: L_W; abbreviation: SWL) and some adjustment factors, depending on the type of noise source.

Table H.1-1 shows the parameters derived for use in train-noise-source modeling. The Surface Transportation Board's Office of Environmental Analysis (OEA) validated these parameters in abstract model scenarios and compared them with hand calculations using the FTA propagation equations. The Cadna-A results were found to under-predict levels by 0.1 to 1.0 A-weighted decibels (dBA). Therefore, a conservative 2 dBA is added to compensate.

Table H.1-1. Train Noise Source Modeling Parameters

Train Noise Source	Point-source Modeling Parameter			
	Type	Quantity[a]	SWL[b] (dBA)	Adjustment[c] (dBA)
Diesel-electric locomotives	Moving	$Q = V \times N_{loco}$	120 + 2 = 122	$+ C_{throttle}$
Railcars	Moving	$Q = V \times N_{cars}$	97 + 2 = 99	$+ 30 \log(S/S_{ref}) + C_{track}$
Locomotive warning horns	Moving	$Q = V$	142 + 2 = 144	+ 0

Where:
Q = Number of noise events for moving point sources
V = Train traffic volume (number of trains)
N_{loco} = Number of locomotives per train
N_{cars} = Number of railcars per train
S = Average speed of train
S_{ref} = Reference speed of 50 mph [80.5 km/h]
$C_{throttle}$ = Adjustment for throttle setting: 0 to 5 = 0 dBA; 6 = 2 dBA; 7 = 4 dBA; 8 = 6 dBA
C_{track} = Adjustment for track conditions: continuous welded rail = 0 dBA; jointed track = 5 dBA

Source: FTA, 2006, Transit Noise and Vibration Impact Assessment, FTA-VA-90-1003-06, Office of Planning and Environment, May, available online at http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf.

Notes:

[a] *Quantities are distributed among daytime (7:00 a.m. to 10:00 p.m.) and nighttime (10:00 p.m. to 7:00 a.m.) proportionately such that an average daytime hour and an average nighttime hour will have equal quantities.*

[b] *Sound power level (SWL) derived from values in FTA's Transit Noise and Vibration Impact Assessment (2006). The moving point-source adjustment +2 is to compensate for under-predicting levels by 0.1 to 1.0 A-weighted decibels (dBA) when computer model is validated against hand-calculations.*

[c] *Adjustment formulas derived from detailed noise assessment formulas in FTA (2006). These are the remaining terms after balancing the FTA equation against the computer-modeling equation for each type of noise source.*

The locomotives and railcars were entered as moving point-sources in the sound propagation model, divided into rail line segments and subsegments. OEA modeled horn noise at all public at-grade crossings (no quiet zones were identified along the rail lines) as moving point-sources.

H.2 SHIELDING

After completing calculations for both existing and proposed train operations, the output of the sound propagation model (that is, noise contours) was imported into the geographic information system (GIS) database. Obstructions that interrupt the line-of-sight to train sound sources provide a measure of shielding and correspondingly reduce sound levels. Therefore, the shielding effects due to intervening buildings were applied within the GIS database (that is, noise contours were adjusted).

This analysis incorporated the shielding elements of the Federal Railroad Administration (FRA) horn noise model (FRA 2000). Aerial photographs were used to identify built-up areas where buildings are likely to provide shielding. In locations with a contiguous built-up area adjacent to the rail line, for example, where the rail line passes through cities and towns, assumptions associated with the FRA's "Light Suburban" shielding condition described below were used to apply shielding values to the sound propagation model results and adjust the noise contours.

The FRA horn noise model uses generalized shielding conditions rather than calculating the shielding due to particular obstructions (FRA 2000). FRA identifies the following shielding conditions:

- Dense Urban
- Light Urban
- Dense Suburban
- Light Suburban
- Rural
- No Shielding

Table H.2-1 shows the assumptions associated with the above shielding conditions.

Table H.2-1. Shielding Condition[a] Parameters

Building Density		Building Environment		
Dense	**Light**	**Urban**	**Suburban**	**Rural[b]**
Shielding Value (dBA)		**Shielding Distance (ft)**		
None	None	< 100	< 200	< 300
5.0	3.0	100 to 300	200 to 400	300 to 500
6.5	4.5	300 to 500	400 to 600	500 to 700
8.0	6.0	500 to 700	600 to 800	700 to 900
9.5	7.5	700 to 900	800 to 1,000	900 to 1,100
11.0	9.0	> 900	> 1,000	> 1,100

Notes:

[a] *Shielding condition is a combination of building density and building environment, such as the shielding condition "Dense Suburban."*

[b] *Rural shielding conditions only use "Light" building density. There is no "Dense Rural" shielding condition.*

H.3 NOISE AND VIBRATION CONTOURS

The analysis generated project-related noise and vibration contours overlaid on publicly available digital aerial photography. The 72-VdB contours for the rail lines and special track intersections are overlaid on aerial photographs in Attachment H-1.

H.4 REFERENCES

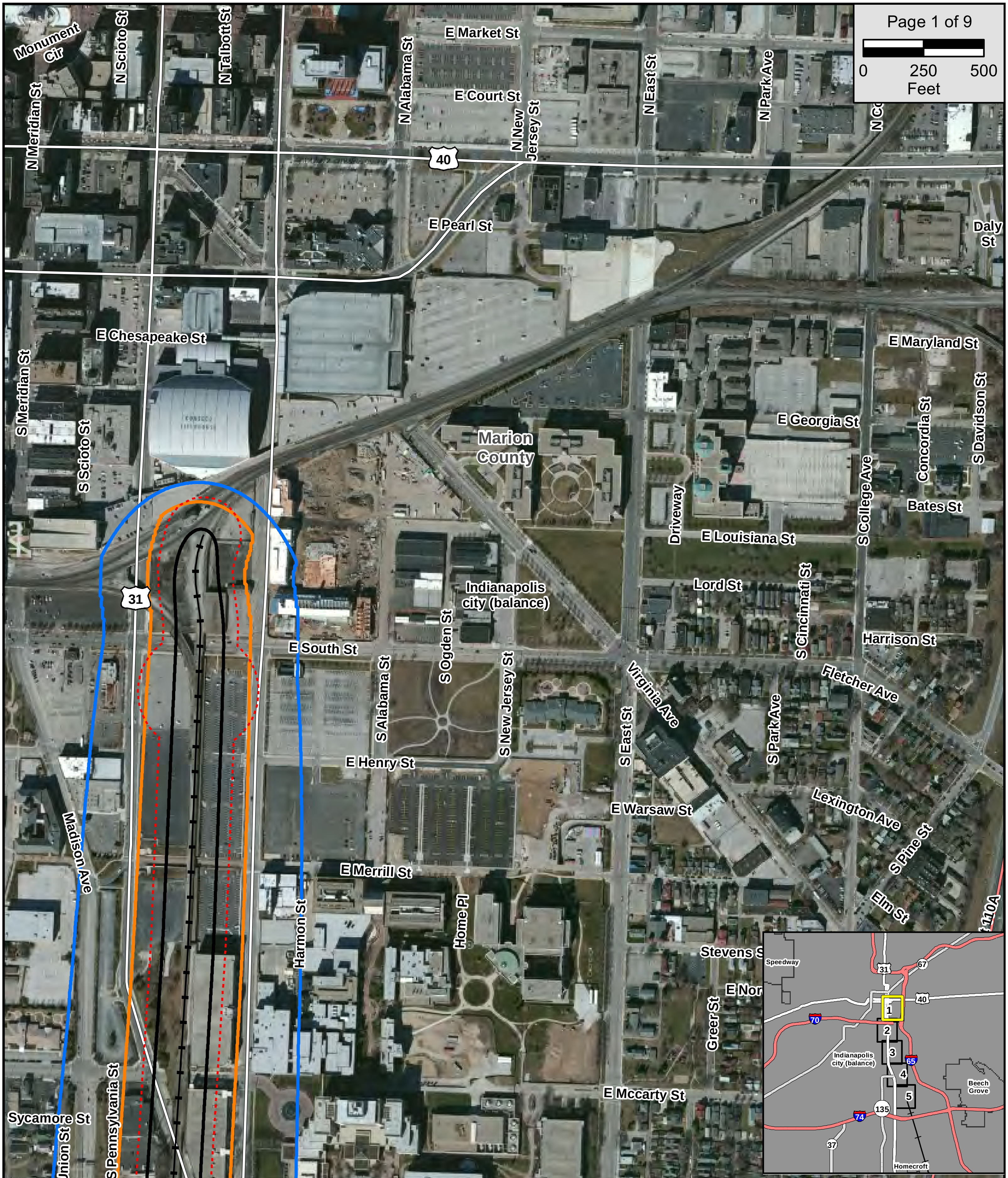
FRA. 2000. "Horn Noise MS Excel spreadsheet model." July 11. Available online at http://www.fra.dot.gov/eLib/Details/L04091.

FTA. 2006. *Transit Noise and Vibration Impact Assessment*. FTA-VA-90-1003-06. Office of Planning and Environment. May. Available online at http://www.fta.dot.gov/documents/FTA_Noise_and_Vibration_Manual.pdf.

ISO. 1996. Standard 9613-2, "Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation."

ATTACHMENT H-1

NOISE AND VIBRATION CONTOURS



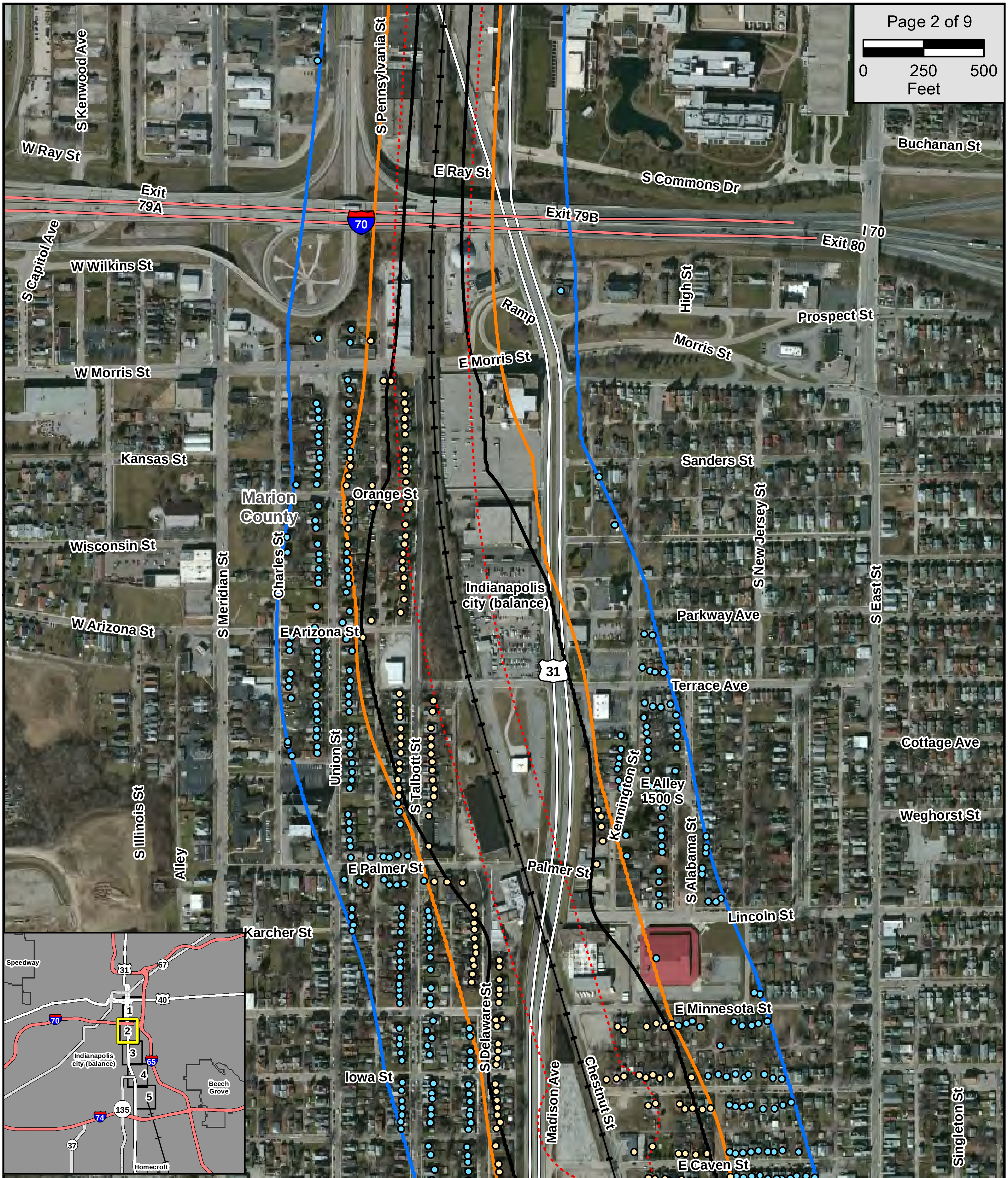
Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Indianapolis Terminal Subdivision – Louisville Secondary Branch
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-06a



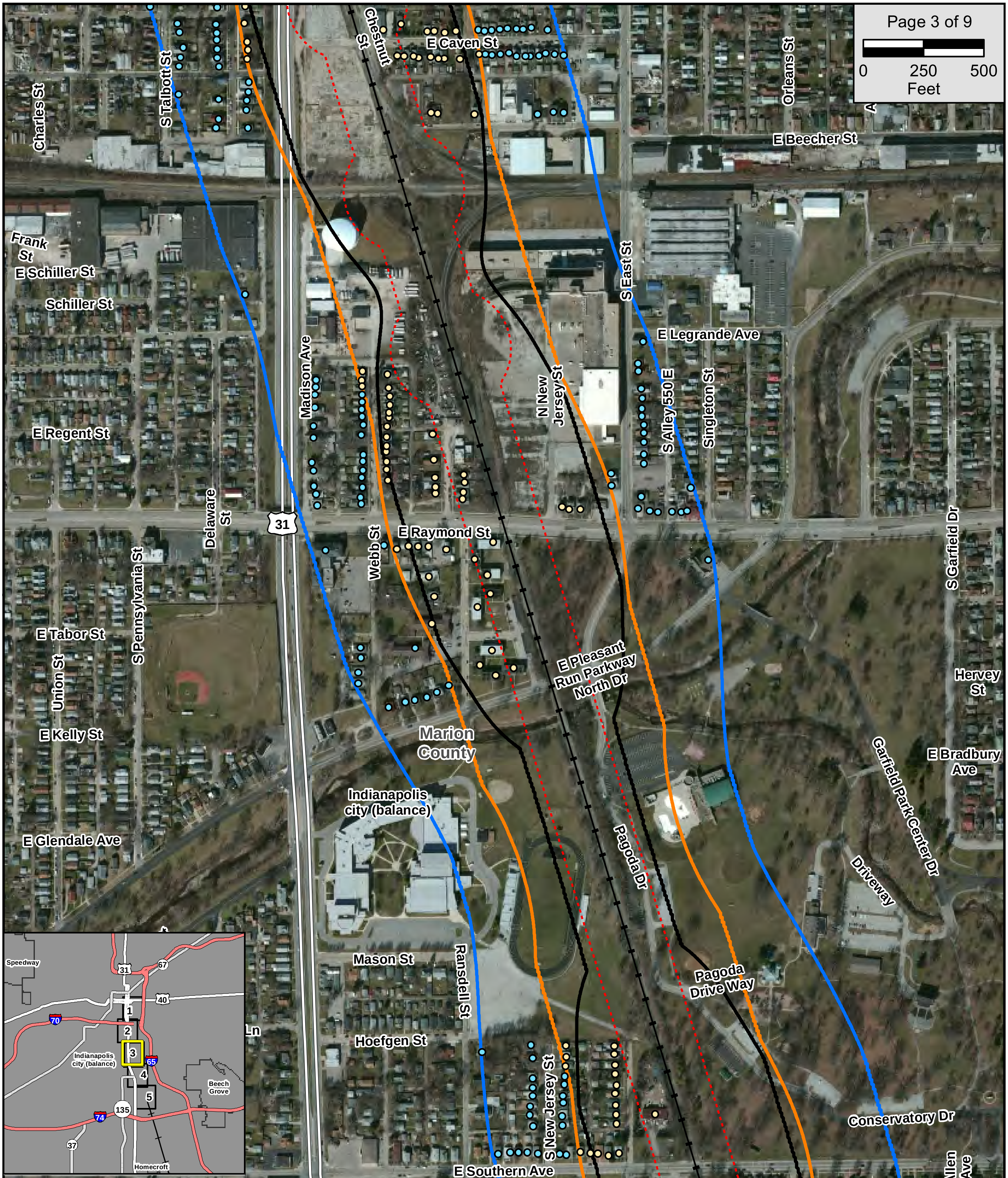
Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Indianapolis Terminal Subdivision – Louisville Secondary Branch
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-06a



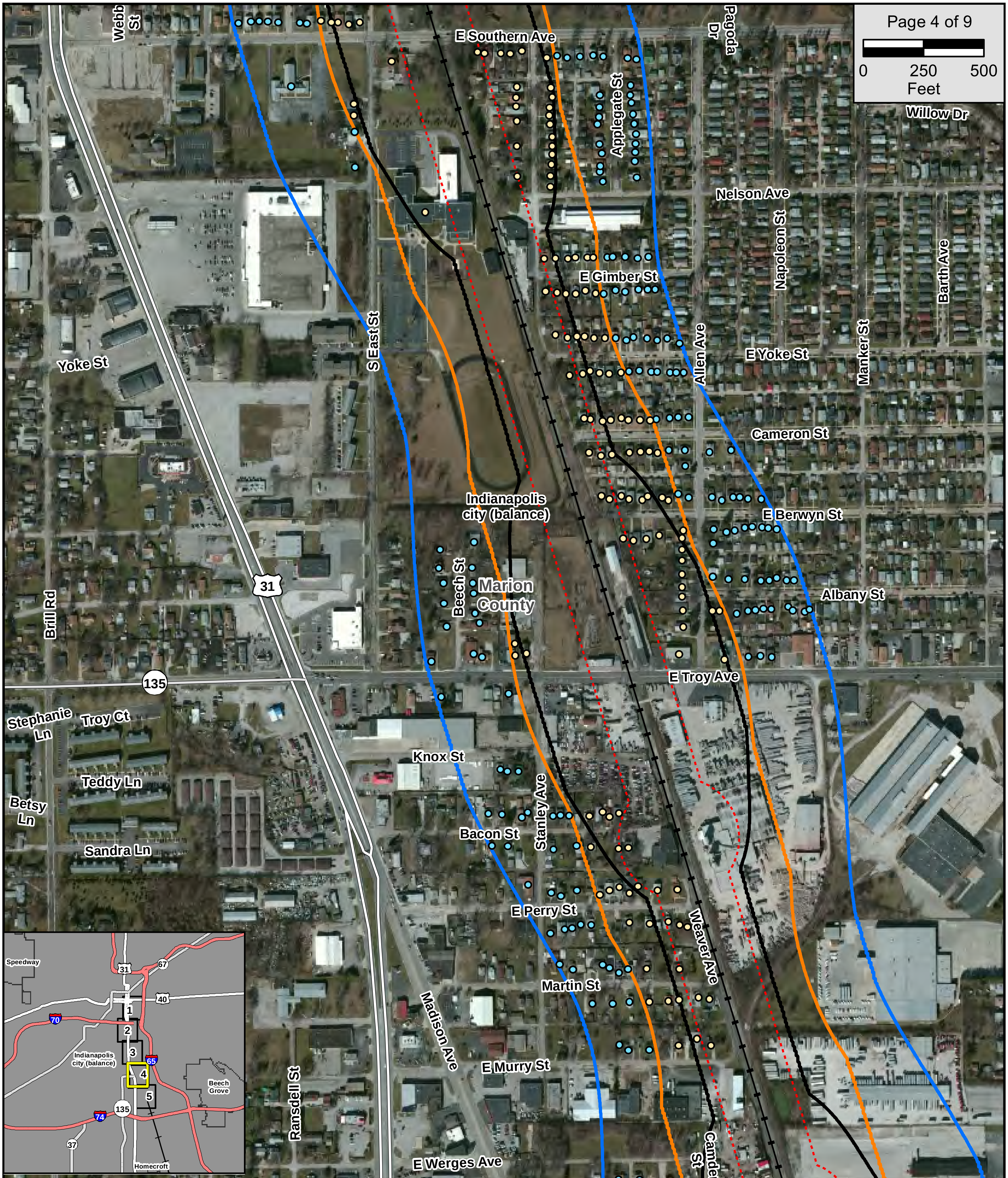
Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Indianapolis Terminal Subdivision – Louisville Secondary Branch
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-06a



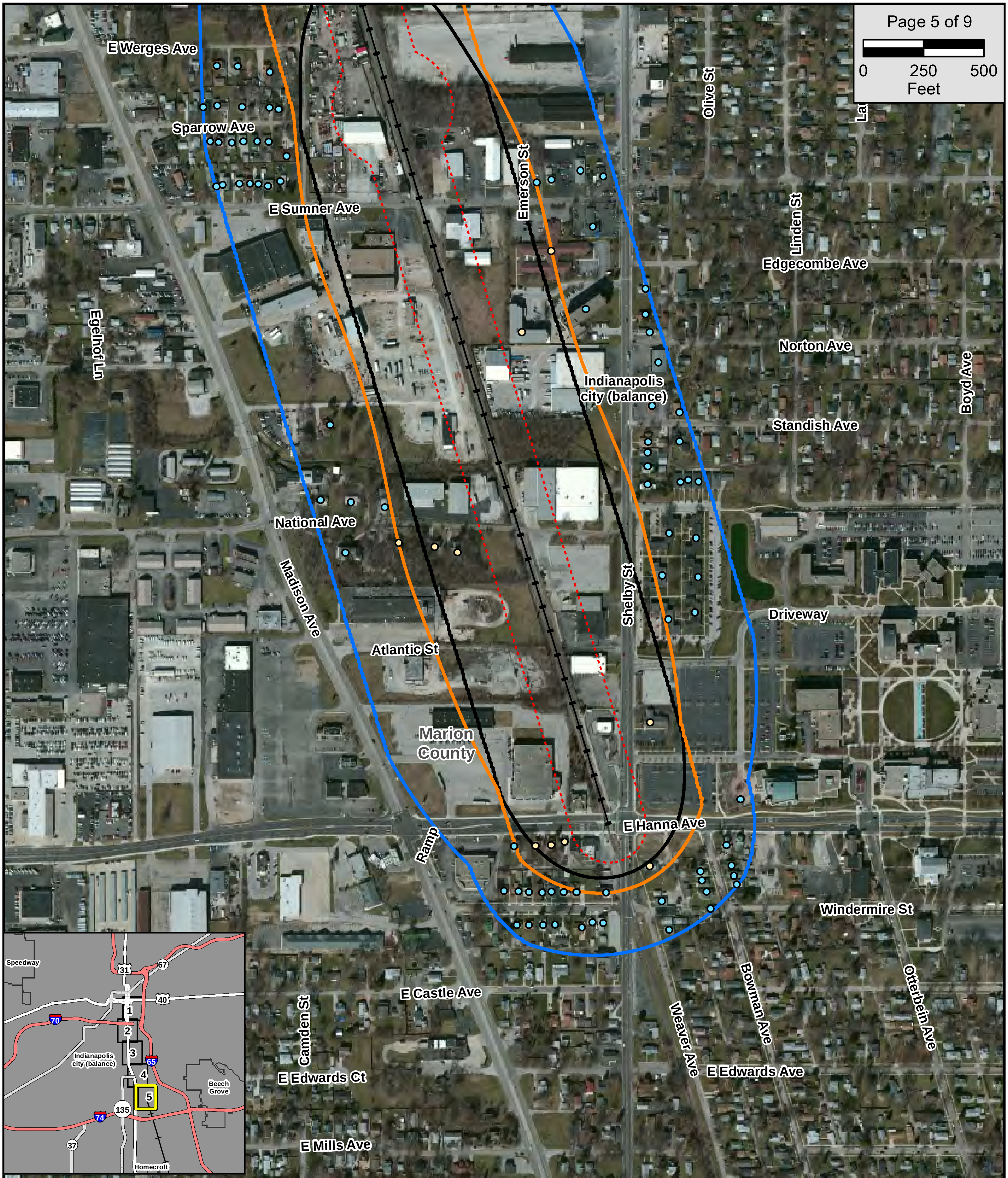
Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Indianapolis Terminal Subdivision – Louisville Secondary Branch
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-06a



Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Indianapolis Terminal Subdivision – Louisville Secondary Branch
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-06a

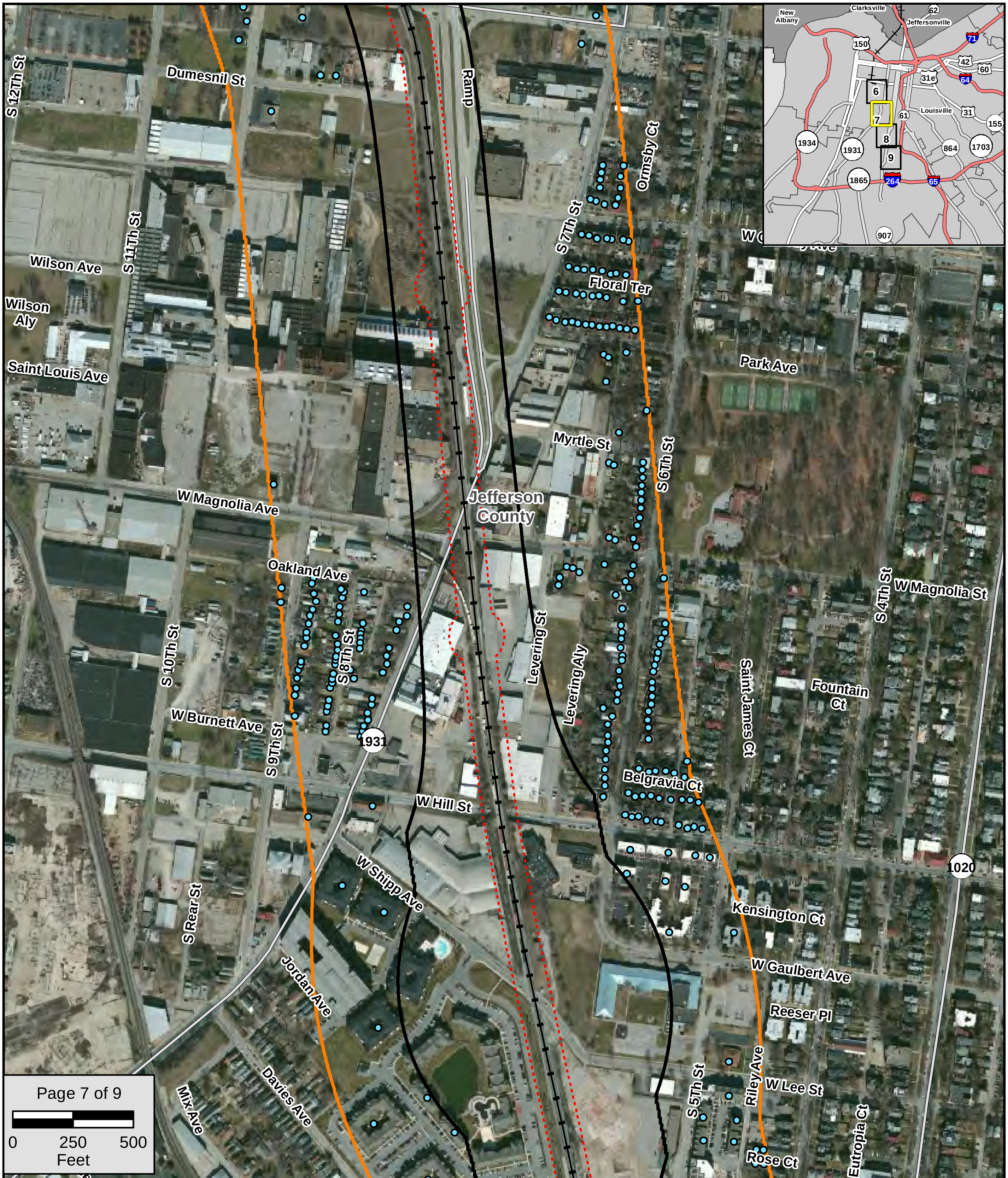
Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Louisville Connection
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-01a



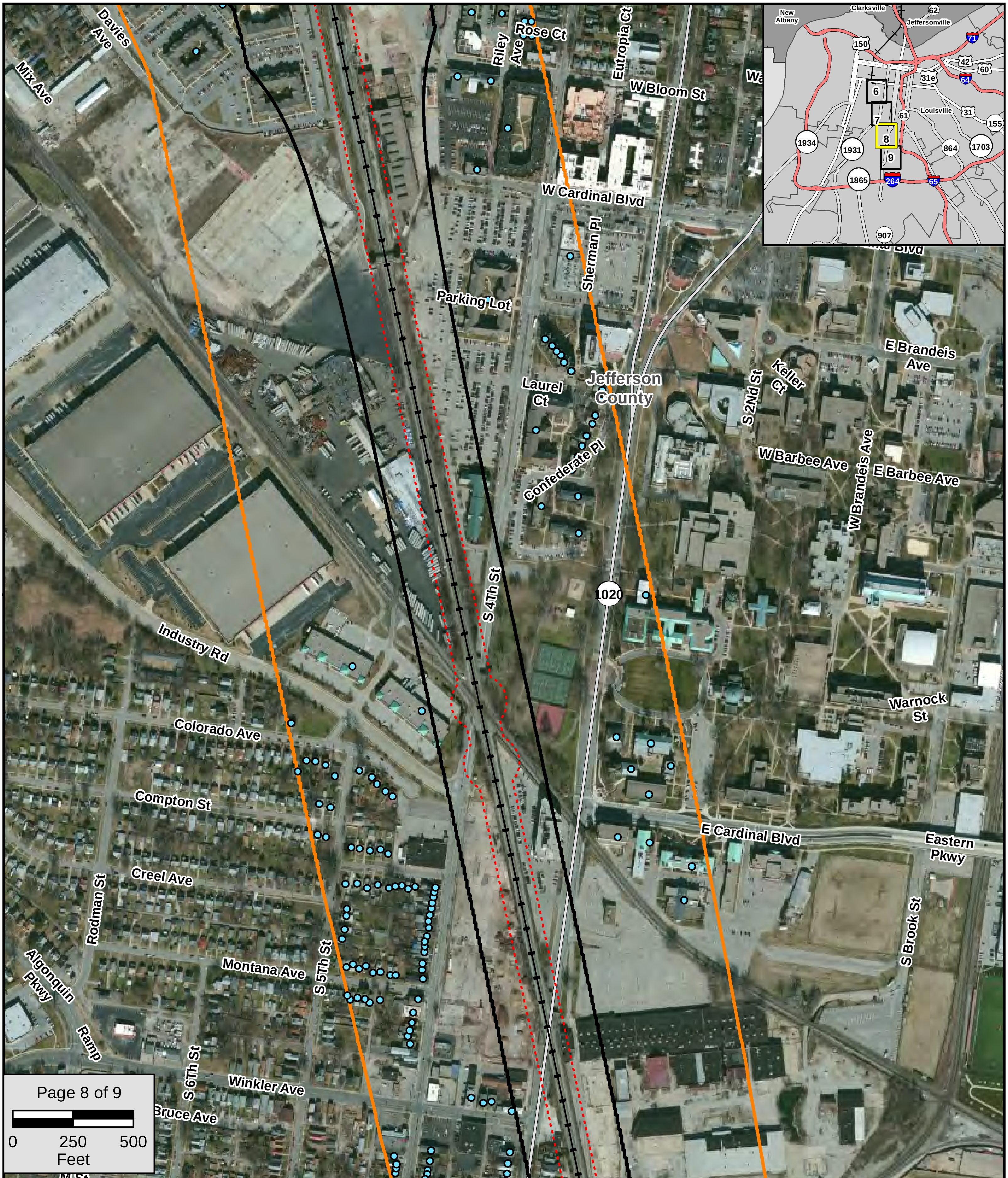
Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Louisville Connection
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-01a



Legend

- 70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
- 65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
- Louisville Connection
- 70 dBA Ldn Contour under the Proposed Action
- 65 dBA Ldn Contour under Existing Conditions
- 72 VdB Contour under Existing and Proposed Conditions
- County Boundary
- City Boundary

N

dBA = Noise Decibels
VdB = Vibration Desibels

Noise and Vibration Analysis Segment CSXT-01a

Winkler Ave
Bruce Ave
M St
S 5Th St
Finn Ave
Iowa Ave
Heywood Ave
S 2Nd St
S 4Th St
Jefferson County
Parking Lot
Central Ave
S Floyd St
Boxley Ave
Helm St
1020
Oakdale Ave
Scanlon St
Harlan Ave
Grant Ave
Terrace Park
Alley
W Collins Ct
E Collins Ct
S Brook St
W Garrett St
E Garrett St
Farmington Ave
Winn Ave
S 3Rd St
Tulane Ave
S 1St St
Rankin St
W Kenton St
E Kenton St
Lennox Ave
Park Blvd
New Albany
Clarksville
Jeffersonville
Louisville
150
62
71
42
60
31e
64
61
31
155
1934
1931
864
1703
1865
264
65
907
6
7
8
9
Page 9 of 9
0
250
500
Feet
Legend
70 dBA Ldn and 5 dBA increase Receptor under the Proposed Action
65 dBA Ldn and 3 dBA increase Receptor under the Proposed Action
Louisville Connection
70 dBA Ldn Contour under the Proposed Action
65 dBA Ldn Contour under Existing Conditions
72 VdB Contour under Existing and Proposed Conditions
County Boundary
City Boundary
N
dBA = Noise Decibels
VdB = Vibration Desibels
Noise and Vibration Analysis Segment CSXT-01a